CLAIMS

What is claimed is:

1. A prosthetic foot device, comprising:

an elongated continuous cantilever-spring, extending from an attachment section coupleable to a stump of an amputee to a toe section at a toe location of a natural foot;

the cantilever-spring being elastically deformable under a load to store energy as the amputee steps onto the cantilever-spring and to release energy as the amputee steps off of the cantilever-spring;

a cam, pivotally coupled to the cantilever-spring at a pivot;

a resistance arm, coupleable to the stump of the amputee, and extending to a displaceable section engaging the cam;

a lever arm, attached to the cantilever-spring, and engaging the cam; and

the cam operatively inter-coupling the cantilever-spring and the resistance arm to elastically deform the resistance arm along with the cantilever-spring to collectively store more energy than the cantilever-spring alone.

2. The device of claim 1, wherein:

the resistance arm and the lever arm initially engage the cam at different distances from the pivot, with the lever arm engaging the cam at a closer distance to the pivot and the resistance arm engaging the cam at a further distance to the pivot; and

the resistance arm and the lever arm engage the cam at varying distances from the pivot as the cam pivots, with the lever arm engaging the cam at a distance varying from closer to further as the cam pivots and with the resistance arm engaging the cam at a distance varying from further to closer as the cam pivots.

3. The device of claim 1, wherein the lever arm and the resistance arm are disposed on opposite sides of the cantilever-spring.

4. The device of claim 3, wherein the cam includes a pair of lobes disposed at different circumferential positions with respect to the pivot.

5. The device of claim 3, wherein the cam includes a dual cam with a pair of lobes disposed at different circumferential positions with respect to the pivot.

6. The device of claim 1, wherein the cam includes a pair of cams fixed to one another and pivotal together, the pair of cams being oriented at different orientations with respect to one another.

7. The device of claim 1, wherein the cam has a pair of tracks extending around at least a portion of a perimeter of the cam, the tracks extending at different circumferential distances from the pivot.

8. The device of claim 1, wherein the cantilever-spring is curvilinear and extends continuously from the attachment section, through an ankle section and an arch section, to the toe section.

9. A prosthetic foot device, comprising:

a plurality of cantilever-springs, being capable of elastic deformation under a load to store and release energy;

a cam, pivotal with respect to the cantilever-springs;

the cam operatively inter-coupling the cantilever-springs such that the cantilever-springs store more energy together than alone; and

one of the cantilever-springs having an attachment section coupleable to a stump of an amputee and defining a unitary foot member extending continuously from the attachment section to a toe section at a toe location of a natural foot.

10. The device of claim 9, further comprising a lever arm, attached to the foot member, and coupleable to the cam

11. The device of claim 10, wherein another of the cantilever-springs defines a resistance arm; and wherein the resistance arm and the lever arm are disposed on opposite sides of the foot member.

12. The device of claim 9, wherein the cam includes a pair of cams fixed to one another and pivotal together, the pair of cams being oriented at different orientations with respect to one another.

13. The device of claim 9, wherein the cam has a pair of tracks extending around at least a portion of a perimeter of the cam, the tracks extending at different circumferential distances from the pivot.

14. The device of claim 9, wherein the foot member is curvilinear and extends continuously from the attachment section, through an ankle section and an arch section, to the toe section.

15. A prosthetic foot device, comprising:

a plurality of cantilever-springs, each having an attachment section coupleable to a stump of an amputee, the cantilever-springs being capable of elastic deformation under a load to store and release energy;

one of the cantilever-springs defining a unitary foot member extending continuously from the attachment section to a toe section at a toe location of a natural foot; and

means for variably inter-coupling the cantilever-springs so that one of the cantilever-springs applies a varying resistance force to the foot member that varies as the foot member deflects.

16. The device of claim 15, wherein the means for variably inter-coupling the cantilever-springs further includes means for inter-coupling the cantilever-springs so that one of the cantilever-springs initially applies a greater force to the foot member.

17. The device of claim 15, wherein the means for variably inter-coupling the cantilever-springs further includes means for inter-coupling the cantilever-springs so that the cantilever-springs together have a non-linear force and deflection relationship.

18. The device of claim 15, wherein the means for variably inter-coupling the cantilever-springs includes a cam pivotal with respect to the cantilever-springs.

19. The device of claim 16, further comprising a lever arm, attached to the foot member, and coupleable to the cam.

20. The device of claim 19, wherein another of the cantilever-springs defines a resistance arm; and wherein the resistance arm and the lever arm are disposed on opposite sides of the foot member.

21. The device of claim 18, wherein the cam includes a pair of cams fixed to one another and pivotal together, the pair of cams being oriented at different orientations with respect to one another.

22. The device of claim 18, wherein the cam has a pair of tracks extending around at least a portion of a perimeter of the cam, the tracks extending at different circumferential distances from the pivot.

23. The device of claim 15, wherein the foot member is curvilinear and extends continuously from the attachment section, through an ankle section and an arch section, to the toe section.

24. The device of claim 15, wherein another of the cantilever-springs defines a resistance arm with a deflection section; and wherein the means for variably inter-coupling the cantilever-springs further includes:

a cam, pivotally coupled to the deflection section of the resistance arm;

a lever arm, coupled to the cam and engaging the foot member; and

a cable, coupled to the cam and engaging the foot member; and wherein

the cantilever-springs are inter-coupled such that the foot member displaces the lever arm as the foot member deflects; the cam pivots as the lever arm displaces; and the

cable pulls the foot member and resistance arm together as the cam pivots.

25. The device of claim 15, wherein another of the cantilever-springs defines a resistance arm with a deflection section; and the means for variably inter-coupling the cantilever-springs further includes:

a cam, pivotally coupled to the deflection section of the resistance arm, the cam having a lobe extending to engage the foot member;

a lever arm, coupled to the cam and engaging the foot member; and wherein

the cantilever-springs are inter-coupled such that the foot member displaces the lever arm as the foot member deflects; the cam pivots as the lever arm displaces; and the lobe pushes the foot member and resistance arm apart as the cam pivots.

26. The device of claim 15, further comprising:

a mounting arm having an attachment section coupleable to the stump of the amputee;

another of the cantilever-springs defining a resistance arm with a deflection section;

the means for variably inter-coupling the cantilever-springs further including:

a cam, pivotally coupled to the mounting arm;

a lever arm, coupled to the cam and engaging the foot member; and

a cable, coupled to the cam and engaging the resistance arm; and wherein

cantilever-springs are inter-coupled such that the foot member displaces the lever arm as the foot member deflects; the cam pivots as the lever arm displaces; and the cable pulls the resistance arm as the cam pivots.

27. The device of claim 15, wherein another of the cantilever-springs defines a resistance arm; and the means for variably inter-coupling the cantilever-springs further includes a linkage, coupled between the foot member and the resistance arm, the linkage including:

a pair of links, coupled in series between the foot member and the resistance arm, the links having an extended length greater than a distance between the foot member and the resistance arm; and

an armature, coupled to the foot member and engaging the linkage; and wherein

the cantilever-springs are inter-coupled such that the foot member displaces the armature as the foot member deflects; the armature extends the pair of links from a shorter length to a greater length as the armature displaces; and the pair of links pushes against the resistance arm as the pair of links extend.

28. The device of claim 15, wherein another of the cantilever-springs defines a resistance arm with a deflection section defining a gap between the foot member and the deflection section of the resistance arm, and the means for variably inter-coupling the cantilever-springs further includes:

a leaf-spring, disposed in the gap and engaging the foot member and the resistance arm, the leaf spring being compressible and having an extendable length during compression; and wherein

the cantilever-springs are inter-coupled such that the foot member compresses the leaf spring as the foot member deflects; and the leaf spring extends in length during compression.